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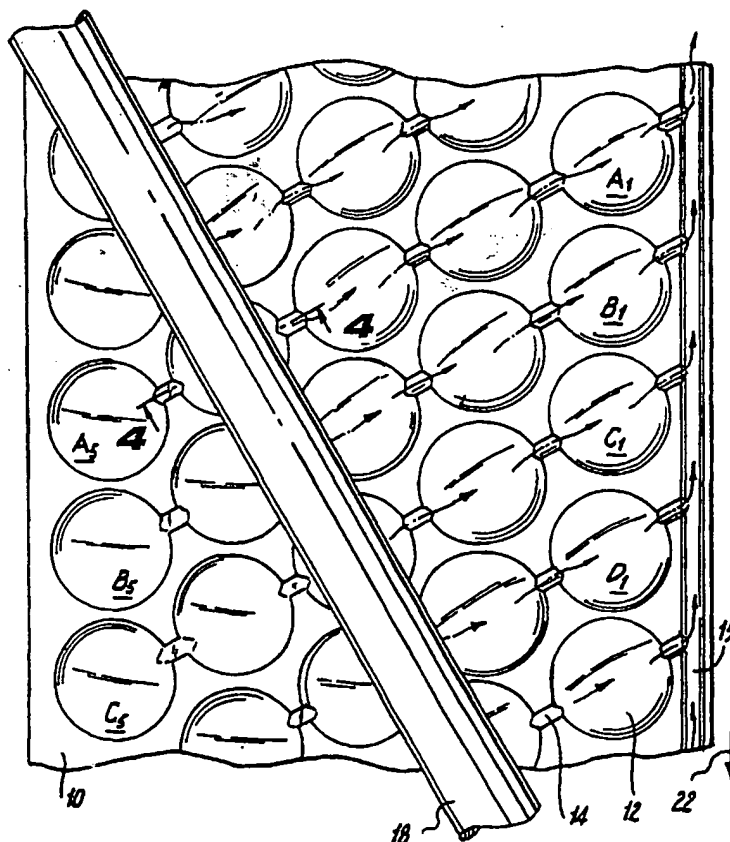
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(54) Title: INFLATABLE AIR CELL DUNNAGE

(57) Abstract

Air cell dunnage is disclosed which collapses for shipment and is constructed to be subsequently inflated for use. The air cell dunnage is a bubble sheet (10) containing a multiplicity of gas cells (12) and a base layer (16) fused to the bubble layer (10). The bubble layer (10) further includes conduits (14) interconnecting selected groups of the selected cells and a common channel (15) extending longitudinally on the sheet (10) in fluid communication with each of the selected groups. The conduits (14) provide access to selected groups of gas cells for collapsing and inflating the cells for shipment and use, respectively.



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INFLATABLE AIR CELL DUNNAGE

This invention relates to air cell dunnage and, more particularly, to air cell dunnage which is intended to be inflated at the time of use.

15 Background of the Invention

Air cell dunnage is typically used for shipping products which may be subject to breakage. The dunnage may be wrapped around the product or stuffed into a container to prevent movement of the product within the container during
20 shipment and to protect against shock.

Conventionally, manufacturing air cell dunnage involves vacuum forming a multiplicity of bubbles to form a bubble layer. The bubbles are separated by flats which are bonded (thermally) to a flat base layer to form a bubble sheet
25 in which air is trapped within the hemispherical vacuum formed bubble. This bubble sheet or air cell dunnage as it is commonly known, is shipped in this form to end users who use the dunnage to package their products for shipment.

The manufactured bubble sheet is relatively bulky,
30 being close to 100 times the thickness of the combined thickness of the plastic film from which the bubble sheet is manufactured. Obviously, this bulk increases the cost of shipping of the manufactured air cell dunnage to the ultimate end user.

35 Moreover, the manufacture of the bubble sheet takes place at relatively high temperature (for example, about 120°C). After the base layer is fused to the bubble layer, the temperature of the bubble sheet drops to room temperature which is approximately 20°C. Because of this drop in temperature,

the volume of the air within the individual bubbles or cells decreases by about 25%. Using these figures, this would mean that only about 75% of the available volume of a bubble is being used. It can be shown that when 75% of the available
5 volume of a bubble is used, the height of the bubble is only 56% of the height of a fully inflated bubble. This means that if the individual bubbles could be expanded to their full size, the bulkiness (thickness) of the product would be almost doubled. Conversely, to achieve the bulkiness of a prior art
10 bubble sheet in which the bubbles are only expanded to 75% of their volume, a fully expanded bubble sheet would require 44% less raw material. Thus, it is desirable to increase the percentage of the available volume of the bubbles which is filled with air.

15 The main object of this invention is to provide air cell dunnage which can be inflated by the end user, which means that the manufactured product is much less bulky than before and which also enables the individual bubbles to be filled with a greater volume of air.

20 A further object of the invention is to provide air cell dunnage in which less material is required for a specified amount of bulkiness.

Summary of the Invention

25 In accordance with the invention, the individual cells of a bubble sheet are interconnected by a series of conduits which lead to atmosphere. When the bubble layer is fused to the base layer, the conduits function as a vent so that the fused bubble sheet can be flattened to evacuate the
30 air within the bubble sheet. The flattened bubble sheet is shipped to the end user.

The end user inflates the bubble sheets by connecting the conduits to an air supply. This will take place at room temperature which means that the individual cells or bubbles
35 can be completely filled with air. After the bubble sheet has been inflated, the individual conduit(s) are sealed so that the captured air is retained within the bubble sheet which can then be used in conventional fashion.

The Drawings

Figure 1 is a plan view of a bubble sheet in accordance with a preferred embodiment of the invention;

Figure 2 is a plan view of a bubble sheet showing a preferred mechanism for expelling air from the bubbles;

Figure 3 is a side sectional view along the line 3-3 of Figure 1;

Figure 4 is a side sectional view along the line 4-4 of Figure 2;

Figure 5 is a plan view showing schematically how the bubbles are inflated and, the conduits sealed; and

Figure 6 is a side sectional view along the line 6-6 of Figure 5.

Detailed Description

Figure 1 shows a bubble layer 10 in accordance with the invention after vacuum forming. A multiplicity of bubbles 12 are typically formed in a diagonal pattern which maximizes the number of bubbles in a given area. In accordance with the invention, in each "diagonal" row, the bubbles 12 are interconnected by means of conduits 14. On one side of the sheet, i.e., the right hand side illustrated in Figure 1, the conduits 14 lead to a channel 15 at the edge of the bubble layer 10. Channel 15 can be used as an exhaust channel for deflating the bubbles and the conduits, and it can be accessed by the end user for the purpose of inflating the bubble sheet as described below.

For purposes of explanation, the interconnected bubbles in a single row have been labeled in Figure 1 with the letters A through Z, respectively, with the right hand bubbles indicated by the subscript 1 and the bubble in the left hand position of the same row by the subscript 5. For example, a single diagonal row of interconnecting bubbles, contains bubbles A₁ through A₅. Typically, the sheet 10 will be about 1.5 meters wide which means that a single diagonal row of bubbles may contain as many as sixty bubbles. The drawings are not intended to illustrate an actual bubble sheet but represent instead a schematic example for purposes of explanation.

By way of example only, if the bubbles 12 are formed as one inch hemispheres, the conduits 14 may be semi-cylindrical forms about 1/8 inch in diameter and channel 15 about 1/4 inch in diameter. They would also be vacuumed formed during the process of manufacturing the bubble layer. This would mean that the roller which contains the female hemispherical dies for forming the bubbles would also include comparable female semi-cylindrical dies for forming the conduits 14 and channel 15. It is also contemplated that the conduits 14 and channel 15 may be formed in the base layer 16, either in whole or in part.

After the bubble layer shown in Figure 1 has been formed, it is joined to a base layer 16 in conventional fashion to form a bubble sheet (Figs. 2 and 3). The base layer 16 contacts the bubble layer only in those regions which are "flat", i.e. the regions outside of the bubbles 12, conduits 14 and channel 15. Typically, layers 10 and 16 are thermally fused together.

In accordance with the invention, after the bubble sheet has been formed, the bubbles are deflated so that the sheet can be shipped in a flattened condition. For this purpose, as shown in Figures 2 and 4, a pair of nip rollers 18 and 20 are provided. The axes of the nip rollers 18 and 20 are arrayed as shown in Figure 2 so that they are perpendicular to the conduits 14 of each diagonal row of bubbles A, B, C, etc. The nip rollers 18 and 20 rotate in the direction of the arrows causing air to be expelled from each row of bubbles through the side channel 15 to atmosphere. Assuming that the bubble sheet moves in the direction of arrow 22 as it is produced, the bubbles shown to the left of the nip rollers 18 and 20 will be flattened and the bubbles on the right hand side will still contain air. It is desirable for the nip rollers 18 and 20 to be transverse to the conduits 14 to make sure that all of the air in a given bubble is expelled by the nip rollers. If the nip rollers were not transversed to conduits 14, air could be trapped within the individual bubbles. The nip rollers 18 and 20 do not function to move the bubble sheet and provide only

negligible resistance to the movement of the bubble sheet as it is produced.

The flattened bubble sheet, as indicated above, may be approximately 100 times thinner than the inflated bubble sheet. Because of this enormous reduction in bulk, the cost of transporting and storing the bubble sheet is greatly reduced.

After the deflated bubble sheet has been shipped, it is necessary to inflate the bubble sheet so that it can be used. For this purpose, apparatus of the type shown schematically in Figure 5 can be employed. The apparatus includes a nozzle 30 having an exterior blade 32 which includes a cutting edge 34, and a heat sealing arrangement which includes two rollers 36 and 38 (Fig. 6). As shown the nozzle 30 is tapered with its wider portion sealing the channel 15 so that air from the nozzle cannot escape.

The flattened bubble sheet typically will be shipped in the form of a large roll as shown at the bottom of Figure 5 at 39 and will be unwound in the direction of arrow 40 using conventional rollers (not shown). The nozzle 30 is inserted into the leading edge of channel 15. Nozzle 30 provides air under pressure which inflates each of the diagonally interconnected rows of bubbles A, B, C, etc. as the bubble sheet is unrolled. The heat sealing process requires the application of heat and pressure to the plastic bubble sheet in the areas of the conduits 14. For this purpose, the upper roller 36 may include a multiplicity of cavities 42 which conform generally to the shapes of the individual air bubbles. The lower roller 38, on the other hand, may be cylindrical in shape with heating wires embedded in the surface of the cylinder to raise the temperature of the plastic sheet to a temperature at which fusion will occur under the pressure applied by the two rollers. The heating wire will trace a path as shown by the dotted lines 44 which ensures that the high temperature is not applied directly to the bubbles and also that the seal at the conduits 14 is generally transverse to the individual conduits.

The heat sealing rollers 36 and 38 are arranged to seal the bubbles after an entire diagonal row has been inflated. For example, as shown in Figure 5, the heat sealing rollers must not seal the conduit 14 between bubble E_1 and channel 15 until all of the bubbles $E_1 - E_5$ have been inflated because after that seal has been made, it is no longer possible to provide air to the remaining bubbles in the diagonal line which has been sealed. After the conduit 14 between bubble E_1 and channel 15 is sealed, as the sheet continues to move in the direction of arrow 40, the conduit 14 between bubbles E_1 and E_2 is sealed and so forth until finally the conduit between bubble E_4 and E_5 is sealed. At this point, each of the bubbles $E_1 - E_5$ is independent of the remaining bubbles.

The same procedure, of course, applies to each successive diagonal row of bubbles. When the leading bubble of each row, e.g. bubble C_1 , reaches the blade 32, cutting edge 34 cuts the channel 15 so that the inflated bubble sheet can be separated from the nozzle 30 for use in conventional fashion. Because the nozzle 30 fits tightly within the channel 15 it is still possible to expand the bubbles through the unsevered portion of channel 15 below the outlet of nozzle 30.

Other arrangements of the conduits can be shown in addition to what is illustrated in Figures 1 and 2. It is not necessary that each diagonal row of bubbles be separately inflatable and any practical number of diagonal rows may be interconnected so that they can be simultaneously inflated.

CLAIMS

1 1. A method of manufacturing collapsed air cell
2 dunnage which can thereafter be inflated for use, comprising:
3 producing a bubble sheet including a bubble layer and
4 a base layer connected thereto;
5 flattening the bubble sheet to expel gas from the
6 bubbles of the bubble sheet; and
7 packaging the flattened bubble sheet for shipment.

1 2. A method of manufacturing collapsed air cell
2 dunnage according to claim 1, wherein the bubble sheet further
3 includes conduits interconnecting selected groups of bubbles
4 and a common channel extending longitudinally on the sheet and
5 in fluid communication with each of the groups through the
6 conduits and the flattening step further comprising depressing
7 a second selected groups of bubbles in sequence so that the gas
8 is expelled through the conduits to the common channel.

1 3. A method of manufacturing collapsed air cell
2 dunnage according to claim 1 wherein the gas is air.

1 4. A method of manufacturing collapsed air cell
2 dunnage which can thereafter be inflated for use, comprising:
3 producing a bubble sheet including a bubble
4 layer with a base layer connected thereof, wherein the bubble
5 sheet includes conduits interconnecting selected groups of
6 bubbles and a common channel extending longitudinally on the
7 sheet and in fluid communication with each of the groups
8 through the conduits; and
9 flattening the bubble sheet to expel gas from
10 the bubbles of the bubble sheet.

1 5. A method of manufacturing air cell dunnage from
2 collapsed air cell dunnage, wherein the collapsed air cell
3 dunnage includes a flattened bubble sheet having a bubble layer

1 and a base layer connected thereto and gas expelled from the
2 bubbles in the bubble sheet, comprising:
3 receiving the flattened bubble sheets which has been
4 shipped;
5 inflating the bubbles in the bubble sheet; and
6 sealing the bubbles in order to retain the gas.

1 6. A method of manufacturing collapsed air cell
2 dunnage according to claim 5 wherein the inflation step occurs
3 at room temperature.

1 7. A method of manufacturing collapsed air cell
2 dunnage according to claim 5 wherein the gas is air.

1 8. A method of manufacturing air cell dunnage from
2 collapsed air cell dunnage, wherein the collapsed air cell
3 dunnage includes a flattened bubble sheet having a bubble layer
4 and a base layer connected thereto, gas expelled from the
5 bubbles in the bubble sheet, conduits interconnecting selected
6 groups of bubbles and a common channel extending longitudinally
7 on the sheet and in fluid communication with each of the groups
8 through the conduits, comprising:
9 inflating the bubbles in the bubble sheet;
10 sealing the bubbles in order to retain the gas; and
11 introducing gas into the common channel for delivery
12 from the conduits to the selected groups of bubbles.

1 9. A method of manufacturing air cell dunnage
2 according to claim 5, wherein the sealing step further
3 comprising sealing the conduits to trap the gas in each of the
4 bubbles.

1 10. A method of manufacturing air cell dunnage,
2 comprising:
3 producing a bubble sheet comprising a bubble layer
4 and a base layer connected thereto,
5 flattening the bubble sheet to expel air from the
6 bubbles,

1 transporting the flattened bubble sheets, and
2 thereafter expanding the bubbles in the bubble sheet.

1 11. A method of producing air cell dunnage according
2 to claim 10 wherein the air cells are sealed after they have
3 been inflated.

1 12. Air cell dunnage, comprising:
2 a bubble sheet containing a multiplicity of gas cells
3 and a base layer fused to the bubble layer, the bubble sheet
4 including conduits interconnecting selected groups of the gas
5 cells and a common channel extending longitudinally on the
6 sheet and in fluid communication with each of the selected
7 groups.

1 13. Air cell dunnage according to claim 12 wherein
2 the gas is air.

1 14. Air cell dunnage according to claim 12 wherein
2 the selected groups of the gas cells are oriented along
3 diagonals on the bubble sheet.

1 15. A method of deflating air cell dunnage including
2 a bubble sheet having a bubble layer and a base layer connected
3 thereto and gas contained in the bubble layer as a result of
4 forming the air cell dunnage, the bubble layer further
5 including conduits interconnecting selected groups of bubbles
6 in the bubble sheet, comprising:
7 rotating rollers during movement of the bubble sheet,
8 the rollers being oriented transverse to the conduits along the
9 selected groups of bubbles and at an angle relative to the
10 movement of the bubble sheet, thereby causing the gas to be
11 expelled from the bubbles in each of the selected groups
12 consecutively such that gas trapped in any of the bubbles
13 during deflation is minimized.

1 16. A device for inflating collapsed air cell
2 dunnage including a flattened bubble sheet having a bubble

1 layer, a base layer connected thereto and gas expelled from the
2 bubbles in the bubble sheet, the bubble layer further including
3 conduits interconnecting selected groups of bubbles and a
4 common channel extending longitudinally on the sheet and in
5 fluid communication with each of the groups through the
6 conduits, comprising:

7 a nozzle including an exterior blade with a cutting
8 edge, the nozzle being inserted into the leading edge of the
9 channel in order to introduce gas under pressure into the
10 channel;

11 a heat sealing device including two rollers
12 constructed to seal the conduits in between the bubbles in the
13 selected groups after the bubbles have been inflated; and

14 the exterior blade adapted to cut the channel so that
15 the inflated air cell dunnage can be separated from the nozzle
16 for use.

1

2 17. A method for inflating collapsed air cell
3 dunnage including a flattened bubble sheet having a bubble
4 layer, a base layer connected thereto and gas expelled from the
5 bubbles in the bubble sheet, the bubble layer further including
6 conduits interconnecting selected groups of bubbles and a
7 common channel extending longitudinally on the sheet and in
8 fluid communication with each of the groups through the
9 conduits, comprising:

10 inserting a nozzle into the leading edge of the
11 channel in order to introduce gas under pressure into the
12 channel;

13 sealing the conduits in between the bubbles after the
14 bubbles have been inflated; and

15 cutting the channel so that the inflated air cell
16 dunnage can be separated from the nozzle for use.

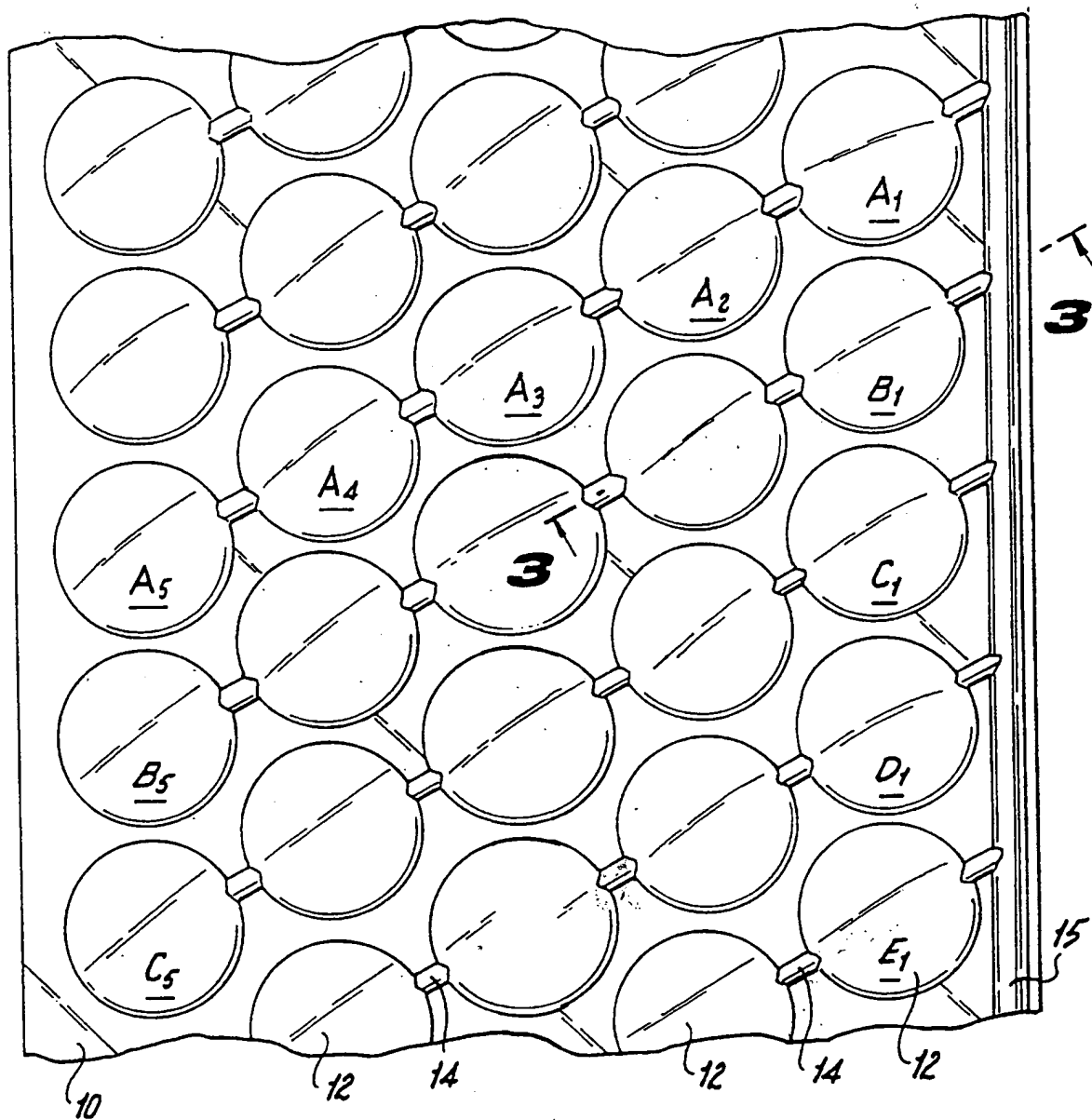


Fig. 1

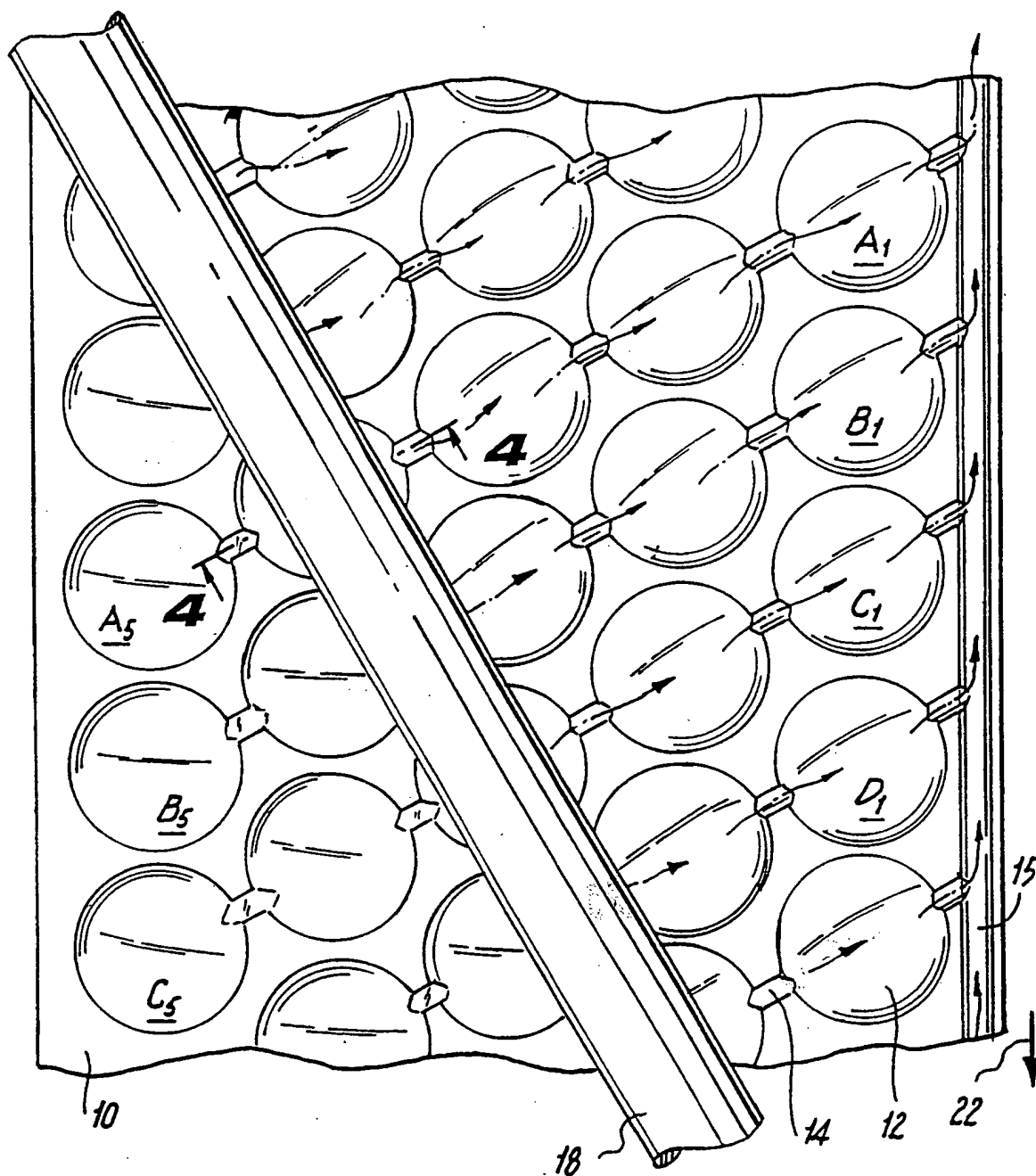


Fig. 2

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Fig. 3

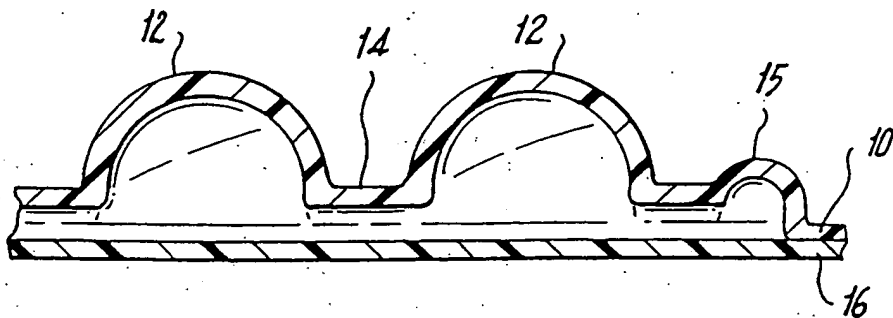


Fig. 4

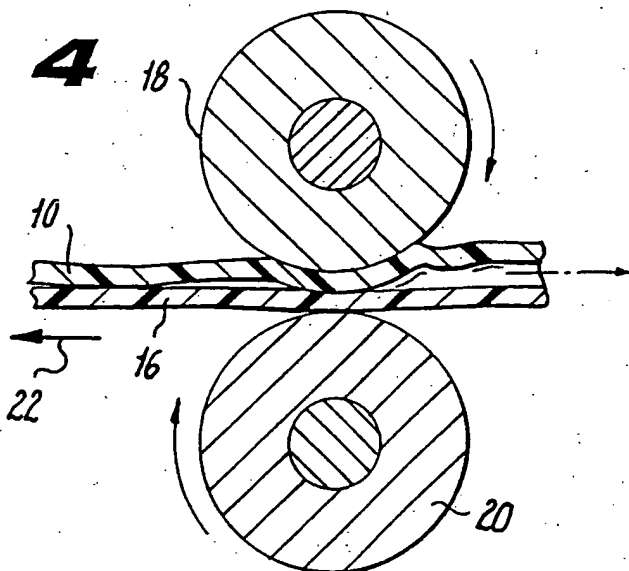
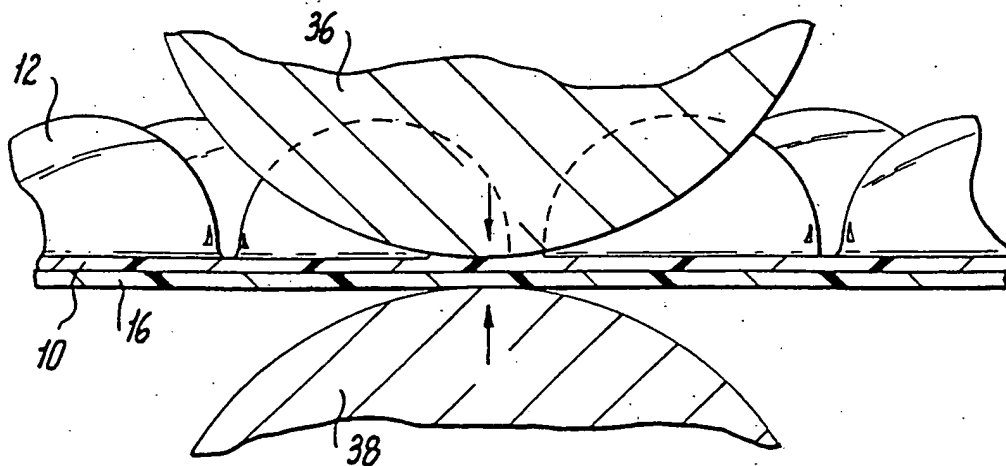


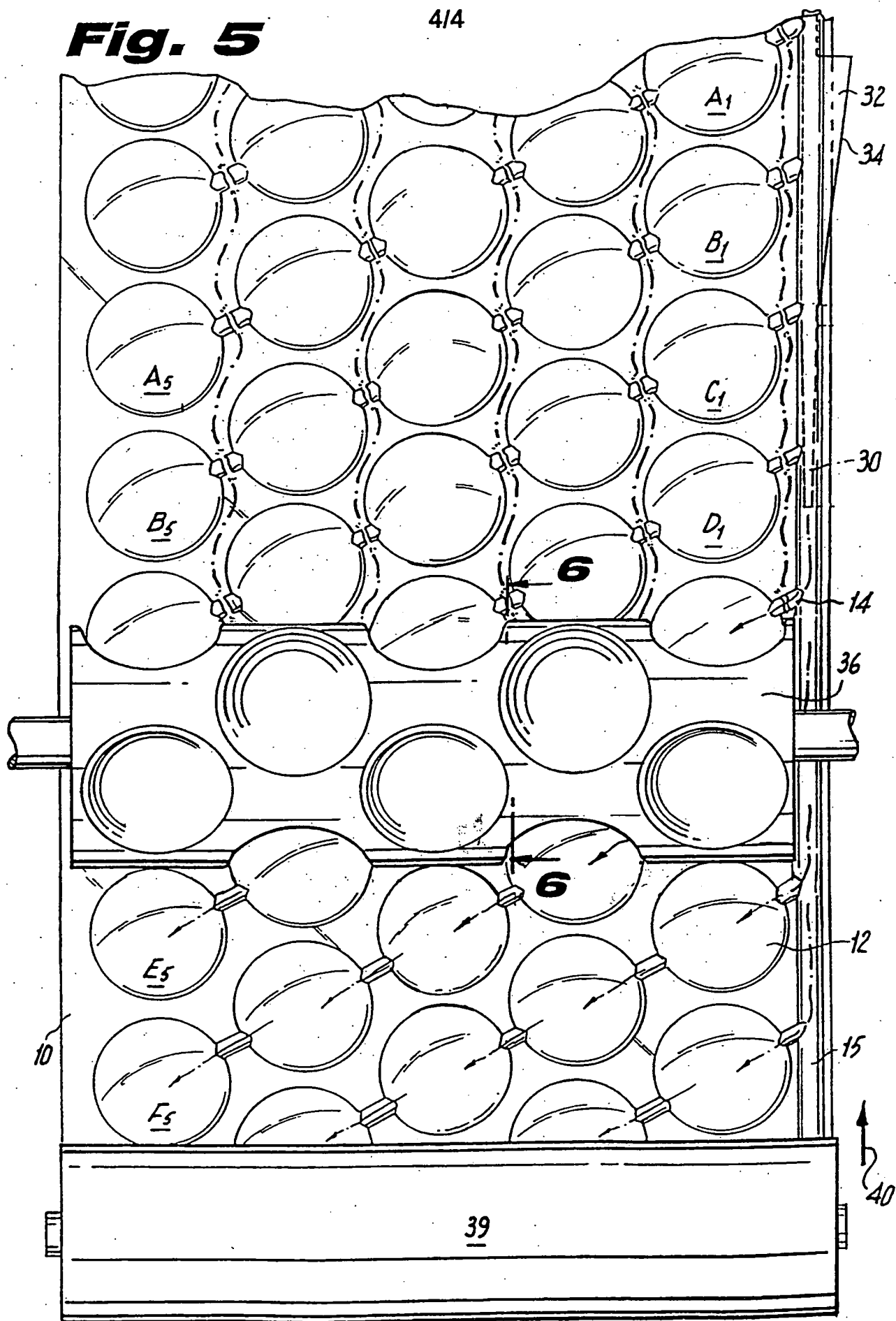
Fig. 6



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Fig. 5



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INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B32B 31/00; B65B 31/00

US CL : 156/145, 147; 53/79, 512

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,096,306 A (LARSON) 20 June 1978 (20.06.78), entire document.	1-17
Y	US 4,017,351 A (LARSON et al) 12 April 1977 (12.04.77), entire document.	1-17
Y	US 5,581,983 A (MURAKAMI) 10 December 1996 (10.12.96), entire document.	1-17
Y	US 5,427,830 A (PHARO) 27 June 1995 (27.06.95), entire document.	1-17
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